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Nonlinear beam fields simulation of a mixed wave and definition of nonlinearity parameter with diffraction correction

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The acoustic nonlinearity parameter has been frequently measured for early detection of micro damage in various materials. The technique typically employs a toneburst signal of single frequency and measures the second harmonic generation during its propagation in through-transmission mode. In this work, we propose a two wave mixing technique and the use of difference frequency components in determining the nonlinearity parameter. One important advantage of this technique is to use difference frequency components apart from higher harmonics including the second harmonic, therefore effects of source nonlinearity can be minimized and low attenuating nonlinear signal can be acquired.

Beam fields radiated from various configurations of radiating transducers are simulated. The fundamental and difference frequency waves are calculated using the multi-Gaussian beam model based on the quasilinear solution for the Westervelt equation. Explicit expressions for diffraction and attenuation corrections are derived, and the nonlinearity parameter is newly defined with these corrections included.

Acknowledgements:

This work was supported by the National Natural Science Foundation of China (Grant Nos. 61271356, 51575541), and by the Basic Science Research Program through the National Research Foundation of Korea (Grant No. 2013-R1A2A2A01016042).